

APPENDIX E
THREATENED AND ENDANGERED SPECIES
REPORTS

Environmental

This form will be completed and submitted to the District Environmental Manager prior to conducting any work below the deck surface on bridges or when required to complete this form for buildings (houses, barns, sheds, etc.). Each bridge/building to be worked on must have a current inventory.

Any bridge/building suspected of providing habitat for any species of bat will be removed from work schedules until such time that VDOT has obtained clearance from the US Fish and Wildlife Service, if required. Additional studies may be undertaken by VDOT to determine what species may be utilizing these assets prior to allowing any work to proceed.

Project Information			
District: Salem	Route: US 220	CEDAR Project No.:	Latitude: -79.861060
	County: Henry	Charge Code:	Longitude: 36.613070

Structure Identifiers			
Federal Structure ID: 010066	Parcel No.:	D No.:	Building Description: <small>If building is not part of an acquisition and does not have a Parcel No. and D No., enter a brief description here</small>
Date of Review: 3/28/19	Deck Height Above Lowest Point <div style="display: flex; justify-content: space-around;"> <div><input type="checkbox"/> ≤ 2'</div> <div><input type="checkbox"/> ≤ 4'</div> <div><input checked="" type="checkbox"/> ≤ 6'</div> </div> <div style="display: flex; justify-content: space-around;"> <div><input type="checkbox"/> ≤ 10'</div> <div><input type="checkbox"/> > 10'</div> </div>		Bat Indicators Check all that apply. Presence of one or more indicators is sufficient evidence that bats may be using the structure. <div style="display: flex; justify-content: space-between;"> <div><input type="checkbox"/> Visual</div> <div><input type="checkbox"/> Sound</div> </div> <div style="display: flex; justify-content: space-between;"> <div>None <u> </u> Droppings (S, M, L)</div> <div><input type="checkbox"/> Staining</div> </div>
Notes No indications that bats are presently inhabiting the bridge. This location is the SB side of US 220/Marrowbone Creek crossing.			
Inventory Conducted By: <u>Scot Aitkenhead</u> Company/Organization: <u>Wallace Montgomery</u> Signature: <u><i>Scot Aitkenhead</i></u>			
District Environmental Use Only			
Date Received by District Environmental Manager: _____			

VDOT Bat Inventory Form Instructions

- Inventories must be completed prior to conducting any work below the bridge deck surface or when required to do so for buildings, regardless of whether inventories have been conducted in the past. **Due to the transitory nature of bat use, a negative result in one year does not guarantee that bats will not use that structure in subsequent years.**
- Initial reviews may be conducted well in advance of proposed work. However, a copy of this form must be completed no more than one year prior to initiating work at each bridge/building location. Legible copies of this document must be provided to the District Environmental Manager within two days of the date of the inventory and no less than two (2) business days prior to beginning work.
- Estimates of numbers of bats observed should be placed in the Notes column.
- Droppings (guano) should be roughly quantified, using the Characterizing Guano Deposits sheet from VDOT's "Preliminary Bat Inventory Guidelines for Bridges." Enter abbreviations for quantities (S, M, L) in Droppings column on form.
- Any questions should be directed to the District Environmental Manager.

Bat Inventory Form Checklist

The following list provides a checklist of items to consider when completing the Bat Inventory Form.

- ☒ Have you used the most recent version of this form and guidelines?
See <https://insidevdot.cov.virginia.gov/Pages/Default.aspx> and search for “Bat Inventory Guidelines” for the current version.
 - ☒ Latitude/Longitude. Record latitude and longitude in decimal degrees (i.e., 36.123456). Longitude should be recorded as a negative number (i.e., -78.12345).
 - ☒ Federal Structure ID. There are TWO structure IDs, a federal ID and a state ID. Insure that the federal ID is used and is 6 digits long. (Sometimes this is truncated to 5 or fewer digits. It’s also possible that a much longer string with many leading zeros is provided. Add or delete zeros in front to reach the required character length.)
 - Example: The federal ID is 12345. Change this to read 012345
 - ☒ Bat Indicators. Insure that droppings (guano) are characterized using the subjective methods in the guidelines and enter the abbreviated letter code in the Droppings field. Check all structural members described below:
 - For bridges. Structural members that should be checked include:
 - pier caps (top surface)
 - horizontal abutment surfaces
 - under deck irregular surfaces (cracks, efflorescence, spalling, etc.)
 - joints
 - For structures. Check any structural gaps, ridge lines or entry points.
- Document any guano or staining. Lack of any indicators should be documented as well.
- ☒ Notes. Describe the location of any observed indicators, using cardinal direction (N, S, E, W) and distance from abutments.
 - Example: 20 bats in 3rd joint E of W abutment
- ☒ Inventory Conducted By. Enter the name of the individual(s) conducting the review.
- ☒ Company/Organization. Enter the name of the company or organization of the person conducting the review.
- ☒ Site Photos. Photos (no smaller than 3” X 5” and of a resolution of at least 6 mega pixels) must be included with the report and, at a minimum, should document representative conditions of each of the structural members listed above, including absence of any indicators. Photos that show the road surface or surrounding landscape are informative, but do not adequately document conditions under the bridge or inside the structure.
- ☒ Bat Photos. If bats are observed, a clear photo should be taken of representative individuals and forwarded to the District Environmental Manager as soon as possible. Good quality photos can make identification easier.







Jon Marc

Josh Barrett



Environmental

This form will be completed and submitted to the District Environmental Manager prior to conducting any work below the deck surface on bridges or when required to complete this form for buildings (houses, barns, sheds, etc.). Each bridge/building to be worked on must have a current inventory.

Any bridge/building suspected of providing habitat for any species of bat will be removed from work schedules until such time that VDOT has obtained clearance from the US Fish and Wildlife Service, if required. Additional studies may be undertaken by VDOT to determine what species may be utilizing these assets prior to allowing any work to proceed.

Project Information			
District: Salem	Route: US 220	CEDAR Project No.:	Latitude: -79.86079
	County: Henry	Charge Code:	Longitude: 36.613058

Structure Identifiers			
Federal Structure ID: 010088	Parcel No.:	D No.:	Building Description: <small>If building is not part of an acquisition and does not have a Parcel No. and D No., enter a brief description here</small>
Date of Review: 3/28/19	Deck Height Above Lowest Point <div style="display: flex; justify-content: space-around;"> <div><input type="checkbox"/> ≤ 2'</div> <div><input type="checkbox"/> ≤ 4'</div> <div><input checked="" type="checkbox"/> ≤ 6'</div> </div> <div style="display: flex; justify-content: space-around;"> <div><input type="checkbox"/> ≤ 10'</div> <div><input type="checkbox"/> > 10'</div> </div>		Bat Indicators Check all that apply. Presence of one or more indicators is sufficient evidence that bats may be using the structure. <div style="display: flex; justify-content: space-between;"> <div><input type="checkbox"/> Visual</div> <div><input type="checkbox"/> Sound</div> </div> <div style="display: flex; justify-content: space-between;"> <div>None <u> </u> Droppings (S, M, L)</div> <div><input type="checkbox"/> Staining</div> </div>
Notes No indications that bats are presently inhabiting the bridge. This location is the NB side of US 220/Marrowbone Creek crossing.			
Inventory Conducted By: <u>Scot Aitkenhead</u> Company/Organization: <u>Wallace Montgomery</u> Signature: <u><i>Scot Aitkenhead</i></u>			
District Environmental Use Only			
Date Received by District Environmental Manager: _____			

VDOT Bat Inventory Form Instructions

- Inventories must be completed prior to conducting any work below the bridge deck surface or when required to do so for buildings, regardless of whether inventories have been conducted in the past. **Due to the transitory nature of bat use, a negative result in one year does not guarantee that bats will not use that structure in subsequent years.**
- Initial reviews may be conducted well in advance of proposed work. However, a copy of this form must be completed no more than one year prior to initiating work at each bridge/building location. Legible copies of this document must be provided to the District Environmental Manager within two days of the date of the inventory and no less than two (2) business days prior to beginning work.
- Estimates of numbers of bats observed should be placed in the Notes column.
- Droppings (guano) should be roughly quantified, using the Characterizing Guano Deposits sheet from VDOT's "Preliminary Bat Inventory Guidelines for Bridges." Enter abbreviations for quantities (S, M, L) in Droppings column on form.
- Any questions should be directed to the District Environmental Manager.

Bat Inventory Form Checklist

The following list provides a checklist of items to consider when completing the Bat Inventory Form.

- ☒ Have you used the most recent version of this form and guidelines?
See <https://insidevdot.cov.virginia.gov/Pages/Default.aspx> and search for “Bat Inventory Guidelines” for the current version.
 - ☒ Latitude/Longitude. Record latitude and longitude in decimal degrees (i.e., 36.123456). Longitude should be recorded as a negative number (i.e., -78.12345).
 - ☒ Federal Structure ID. There are TWO structure IDs, a federal ID and a state ID. Insure that the federal ID is used and is 6 digits long. (Sometimes this is truncated to 5 or fewer digits. It’s also possible that a much longer string with many leading zeros is provided. Add or delete zeros in front to reach the required character length.)
 - Example: The federal ID is 12345. Change this to read 012345
 - ☒ Bat Indicators. Insure that droppings (guano) are characterized using the subjective methods in the guidelines and enter the abbreviated letter code in the Droppings field. Check all structural members described below:
 - For bridges. Structural members that should be checked include:
 - pier caps (top surface)
 - horizontal abutment surfaces
 - under deck irregular surfaces (cracks, efflorescence, spalling, etc.)
 - joints
 - For structures. Check any structural gaps, ridge lines or entry points.
- Document any guano or staining. Lack of any indicators should be documented as well.
- ☒ Notes. Describe the location of any observed indicators, using cardinal direction (N, S, E, W) and distance from abutments.
 - Example: 20 bats in 3rd joint E of W abutment
- ☒ Inventory Conducted By. Enter the name of the individual(s) conducting the review.
- ☒ Company/Organization. Enter the name of the company or organization of the person conducting the review.
- ☒ Site Photos. Photos (no smaller than 3” X 5” and of a resolution of at least 6 mega pixels) must be included with the report and, at a minimum, should document representative conditions of each of the structural members listed above, including absence of any indicators. Photos that show the road surface or surrounding landscape are informative, but do not adequately document conditions under the bridge or inside the structure.
- ☒ Bat Photos. If bats are observed, a clear photo should be taken of representative individuals and forwarded to the District Environmental Manager as soon as possible. Good quality photos can make identification easier.









































































Environmental

This form will be completed and submitted to the District Environmental Manager prior to conducting any work below the deck surface on bridges or when required to complete this form for buildings (houses, barns, sheds, etc.). Each bridge/building to be worked on must have a current inventory.

Any bridge/building suspected of providing habitat for any species of bat will be removed from work schedules until such time that VDOT has obtained clearance from the US Fish and Wildlife Service, if required. Additional studies may be undertaken by VDOT to determine what species may be utilizing these assets prior to allowing any work to proceed.

Project Information			
District: Salem	Route: VA 641	CEDAR Project No.:	Latitude: -79.879978
	County: Henry	Charge Code:	Longitude: 36.608553

Structure Identifiers			
Federal Structure ID: 010124	Parcel No.:	D No.:	Building Description: <small>If building is not part of an acquisition and does not have a Parcel No. and D No., enter a brief description here</small>
Date of Review: 3/28/19	Deck Height Above Lowest Point <input checked="" type="checkbox"/> ≤ 2' <input type="checkbox"/> ≤ 4' <input type="checkbox"/> ≤ 6' <input type="checkbox"/> ≤ 10' <input type="checkbox"/> > 10'		Bat Indicators Check all that apply. Presence of one or more indicators is sufficient evidence that bats may be using the structure. <input type="checkbox"/> Visual <input type="checkbox"/> Sound None <u> </u> Droppings (S, M, L) <input type="checkbox"/> Staining
Notes No indications that bats are presently inhabiting the Culvert. Culvert appears to have been recently replaced or embankment stabilization has occurred. Silt fence has not been removed yet.			
Inventory Conducted By: <u>Scot Aitkenhead</u> Company/Organization: <u>Wallace Montgomery</u> Signature: <u><i>Scot Aitkenhead</i></u>			
District Environmental Use Only			
Date Received by District Environmental Manager: _____			

VDOT Bat Inventory Form Instructions

- Inventories must be completed prior to conducting any work below the bridge deck surface or when required to do so for buildings, regardless of whether inventories have been conducted in the past. **Due to the transitory nature of bat use, a negative result in one year does not guarantee that bats will not use that structure in subsequent years.**
- Initial reviews may be conducted well in advance of proposed work. However, a copy of this form must be completed no more than one year prior to initiating work at each bridge/building location. Legible copies of this document must be provided to the District Environmental Manager within two days of the date of the inventory and no less than two (2) business days prior to beginning work.
- Estimates of numbers of bats observed should be placed in the Notes column.
- Droppings (guano) should be roughly quantified, using the Characterizing Guano Deposits sheet from VDOT's "Preliminary Bat Inventory Guidelines for Bridges." Enter abbreviations for quantities (S, M, L) in Droppings column on form.
- Any questions should be directed to the District Environmental Manager.

Bat Inventory Form Checklist

The following list provides a checklist of items to consider when completing the Bat Inventory Form.

- ☒ Have you used the most recent version of this form and guidelines?
See <https://insidevdot.cov.virginia.gov/Pages/Default.aspx> and search for “Bat Inventory Guidelines” for the current version.
 - ☒ Latitude/Longitude. Record latitude and longitude in decimal degrees (i.e., 36.123456). Longitude should be recorded as a negative number (i.e., -78.12345).
 - ☒ Federal Structure ID. There are TWO structure IDs, a federal ID and a state ID. Insure that the federal ID is used and is 6 digits long. (Sometimes this is truncated to 5 or fewer digits. It’s also possible that a much longer string with many leading zeros is provided. Add or delete zeros in front to reach the required character length.)
 - Example: The federal ID is 12345. Change this to read 012345
 - ☒ Bat Indicators. Insure that droppings (guano) are characterized using the subjective methods in the guidelines and enter the abbreviated letter code in the Droppings field. Check all structural members described below:
 - For bridges. Structural members that should be checked include:
 - pier caps (top surface)
 - horizontal abutment surfaces
 - under deck irregular surfaces (cracks, efflorescence, spalling, etc.)
 - joints
 - For structures. Check any structural gaps, ridge lines or entry points.
- Document any guano or staining. Lack of any indicators should be documented as well.
- ☒ Notes. Describe the location of any observed indicators, using cardinal direction (N, S, E, W) and distance from abutments.
 - Example: 20 bats in 3rd joint E of W abutment
- ☒ Inventory Conducted By. Enter the name of the individual(s) conducting the review.
- ☒ Company/Organization. Enter the name of the company or organization of the person conducting the review.
- ☒ Site Photos. Photos (no smaller than 3” X 5” and of a resolution of at least 6 mega pixels) must be included with the report and, at a minimum, should document representative conditions of each of the structural members listed above, including absence of any indicators. Photos that show the road surface or surrounding landscape are informative, but do not adequately document conditions under the bridge or inside the structure.
- ☒ Bat Photos. If bats are observed, a clear photo should be taken of representative individuals and forwarded to the District Environmental Manager as soon as possible. Good quality photos can make identification easier.









Environmental

This form will be completed and submitted to the District Environmental Manager prior to conducting any work below the deck surface on bridges or when required to complete this form for buildings (houses, barns, sheds, etc.). Each bridge/building to be worked on must have a current inventory.

Any bridge/building suspected of providing habitat for any species of bat will be removed from work schedules until such time that VDOT has obtained clearance from the US Fish and Wildlife Service, if required. Additional studies may be undertaken by VDOT to determine what species may be utilizing these assets prior to allowing any work to proceed.

Project Information			
District: Salem	Route: VA 687	CEDAR Project No.:	Latitude: -79.878455
	County: Henry	Charge Code:	Longitude: 36.594301

Structure Identifiers			
Federal Structure ID: 023672	Parcel No.:	D No.:	Building Description: <small>If building is not part of an acquisition and does not have a Parcel No. and D No., enter a brief description here</small>
Date of Review: 3/28/19	Deck Height Above Lowest Point <div style="display: flex; justify-content: space-around;"> <div><input type="checkbox"/> ≤ 2'</div> <div><input checked="" type="checkbox"/> ≤ 4'</div> <div><input type="checkbox"/> ≤ 6'</div> </div> <div style="display: flex; justify-content: space-around;"> <div><input type="checkbox"/> ≤ 10'</div> <div><input type="checkbox"/></div> <div><input type="checkbox"/> > 10'</div> </div>		Bat Indicators Check all that apply. Presence of one or more indicators is sufficient evidence that bats may be using the structure. <div style="display: flex; justify-content: space-between;"> <div><input type="checkbox"/> Visual</div> <div><input type="checkbox"/> Sound</div> </div> <div style="display: flex; justify-content: space-between;"> <div>None <u> </u> Droppings (S, M, L)</div> <div><input type="checkbox"/> Staining</div> </div>
Notes No indications that bats are presently inhabiting the bridge. This location is Soapstone Road over Marrowbone Creek crossing. Deck height above lowest point calculated at sloped embankments; however, majority of deck height is >10ft above stream.			
Inventory Conducted By: <u>Scot Aitkenhead</u> Company/Organization: <u>Wallace Montgomery</u> Signature: <u><i>Scot Aitkenhead</i></u>			
District Environmental Use Only			
Date Received by District Environmental Manager: _____			

VDOT Bat Inventory Form Instructions

- Inventories must be completed prior to conducting any work below the bridge deck surface or when required to do so for buildings, regardless of whether inventories have been conducted in the past. **Due to the transitory nature of bat use, a negative result in one year does not guarantee that bats will not use that structure in subsequent years.**
- Initial reviews may be conducted well in advance of proposed work. However, a copy of this form must be completed no more than one year prior to initiating work at each bridge/building location. Legible copies of this document must be provided to the District Environmental Manager within two days of the date of the inventory and no less than two (2) business days prior to beginning work.
- Estimates of numbers of bats observed should be placed in the Notes column.
- Droppings (guano) should be roughly quantified, using the Characterizing Guano Deposits sheet from VDOT's "Preliminary Bat Inventory Guidelines for Bridges." Enter abbreviations for quantities (S, M, L) in Droppings column on form.
- Any questions should be directed to the District Environmental Manager.

Bat Inventory Form Checklist

The following list provides a checklist of items to consider when completing the Bat Inventory Form.

- ☒ Have you used the most recent version of this form and guidelines?
See <https://insidevdot.cov.virginia.gov/Pages/Default.aspx> and search for “Bat Inventory Guidelines” for the current version.
 - ☒ Latitude/Longitude. Record latitude and longitude in decimal degrees (i.e., 36.123456). Longitude should be recorded as a negative number (i.e., -78.12345).
 - ☒ Federal Structure ID. There are TWO structure IDs, a federal ID and a state ID. Insure that the federal ID is used and is 6 digits long. (Sometimes this is truncated to 5 or fewer digits. It’s also possible that a much longer string with many leading zeros is provided. Add or delete zeros in front to reach the required character length.)
 - Example: The federal ID is 12345. Change this to read 012345
 - ☒ Bat Indicators. Insure that droppings (guano) are characterized using the subjective methods in the guidelines and enter the abbreviated letter code in the Droppings field. Check all structural members described below:
 - For bridges. Structural members that should be checked include:
 - pier caps (top surface)
 - horizontal abutment surfaces
 - under deck irregular surfaces (cracks, efflorescence, spalling, etc.)
 - joints
 - For structures. Check any structural gaps, ridge lines or entry points.
- Document any guano or staining. Lack of any indicators should be documented as well.
- ☒ Notes. Describe the location of any observed indicators, using cardinal direction (N, S, E, W) and distance from abutments.
 - Example: 20 bats in 3rd joint E of W abutment
- ☒ Inventory Conducted By. Enter the name of the individual(s) conducting the review.
- ☒ Company/Organization. Enter the name of the company or organization of the person conducting the review.
- ☒ Site Photos. Photos (no smaller than 3” X 5” and of a resolution of at least 6 mega pixels) must be included with the report and, at a minimum, should document representative conditions of each of the structural members listed above, including absence of any indicators. Photos that show the road surface or surrounding landscape are informative, but do not adequately document conditions under the bridge or inside the structure.
- ☒ Bat Photos. If bats are observed, a clear photo should be taken of representative individuals and forwarded to the District Environmental Manager as soon as possible. Good quality photos can make identification easier.































Survey of Stream Fish Habitat at Five Potential Bridge Crossing Sites for the New U.S. Route 220 Southern Connector (Martinsville, VA)

Project Report
Project: UPC 110916

By:

Logan J. Sleezer*

Department of Fish and Wildlife Conservation, Virginia Polytechnic and
State University, Blacksburg, Virginia 24061

and

Paul L. Angermeier

U.S. Geological Survey, Virginia Cooperative Fish and Wildlife
Research Unit, Virginia Polytechnic and State University, Blacksburg,
Virginia 24061

*corresponding author: slogan3@vt.edu

For:

Virginia Department of Transportation
1201 E. Broad St.
Richmond, VA 23219

May 2019

EXECUTIVE SUMMARY

Marrowbone Creek is a tributary to the Smith River in the upper Dan River basin. The Dan River basin is part of the native range of both the federally endangered Roanoke Logperch (*Percina rex*) and the Orange-fin Madtom (*Noturus gilberti*), which is currently a candidate for federal listing under the U.S. Endangered Species Act. A population of Roanoke Logperch is known to be established within the upper Smith River (Martin and Angermeier, 2018), putting them in close proximity to Marrowbone Creek and the proposed bridge crossing sites. The construction of bridges can be destructive to riparian vegetation surrounding streams, increasing the potential for erosion and deposition of fine sediment downstream. Bridges can also negatively affect water quality well after construction through run-off of road treatment substances such as salts. Thus, because of the potential adverse effects of a new bridge construction project on fine sediment deposition and water quality within Marrowbone Creek and its proximity to populations of *P. rex* and *N. gilberti* (both considered intolerant of fine sediment pollution and degraded water quality), habitat assessments were needed to assess the suitability of Marrowbone Creek to support both of these species at five prospective bridge crossing locations (Figure 1). Thus, two biologists from Virginia Tech's Department of Fish and Wildlife Conservation conducted fish habitat surveys on 15-17 May 2019. Benthic habitat at all five potential bridge sites along Marrowbone Creek was dominated by silt and sand. Therefore, due to the intolerance of both *P. rex* and *N. gilberti* to fine sediment, we found all five alternative sites to contain habitat unsuitable for both of these focal species. With this being said, Marrowbone Creek at the Alternative A crossing appeared to contain the most diverse benthic habitat and the most intact riparian canopy, which combine to make this site most suitable to a wide range of fish species. Given these findings, building the bridge anywhere other than Alternative A would likely ensure the least negative impacts of bridge construction and maintenance on habitat for native fishes.

SAMPLING PROTOCOL

Qualitative habitat assessments are sufficient to measure a stream's capacity to support *P. rex* and *N. gilberti* in most cases. Medium to large streams and small rivers with good apparent physical and chemical water quality and availability of deep, swift riffle-runs with little to no silt are considered suitable habitat for *P. rex* (Jenkins and Burkhead, 1994; Rosenberger and Angermeier, 2003). Suitable locations for *N. gilberti* are high-gradient small to large streams with abundant moderate- to swift-current runs and riffles, containing little to no silt or sand and an abundance of small cobble substrate (Jenkins and Burkhead, 1994; Simonson and Neves, 1992). In this case, qualitative habitat assessments were sufficient to assess the suitability of Marrowbone Creek at all five potential bridge crossing sites for both of these species. Two biologists from Virginia Tech's Department of Fish and Wildlife Conservation conducted these fish habitat surveys on 15-17 May 2019.

The habitat surveys at each potential crossing were conducted starting 200 m upstream of each proposed bridge crossing site and ending 600 m downstream of the proposed bridge sites. Habitat was sampled at 21 transects perpendicular to stream flow. Transects upstream of each

proposed bridge site were spaced at 25-m intervals and transects downstream of the proposed bridge sites were spaced at 50-m intervals (as specified by Martin and Angermeier, 2015). At each transect, we measured wetted width of the stream (m), water depth (cm), dominant substrate type (based on a modified Wentworth scale; Table 1), sub-dominant substrate type, percent silt-cover, and percent embeddedness (a measure of the degree of silt/sand build-up within the interstitial spaces between larger substrate particles) at evenly spaced intervals across the width of the stream.

RESULTS AND DISCUSSION

Benthic habitat at all alternative bridge crossing sites over Marrowbone Creek was dominated by silt and sand substrate. In addition, swift riffle mesohabitat was quite scarce across all sites. While the size and depth of Marrowbone Creek seems somewhat amenable to both *N. gilberti* and *P. rex*, the preponderance of fine substrate and lack of riffle habitats makes all proposed alternative bridge construction sites and the stream reaches that would likely be affected by this project very poor habitat for *N. gilberti* and *P. rex*. Therefore, the construction of a bridge at any of the proposed alternative locations is unlikely to have negative effects on either of these species.

However, despite the fact that Marrowbone Creek does not appear to be suitable for *N. gilberti* or *P. rex*, the final bridge construction location could still be selected to limit the potential for negative impacts on other native fishes as well as the surrounding forest. For example, although we were not able to complete our sampling protocols at Alternative A due to a close encounter with a female black bear and her cubs, this site appeared to be the most diverse in terms of available benthic habitat for fishes and it also appeared to have the most intact riparian forest. Alternative B also appeared to have a healthy riparian forest. Inputs of leaf litter and terrestrial insects from the riparian zone into small streams, such as Marrowbone Creek, can be critical to the structure and function of instream communities. Intact riparian forests can also mediate stream temperatures and limit streambank erosion and fine sediment deposition within small streams.

In contrast to Alternatives A and B, the streambanks of stream reaches downstream of Alternatives C and D have been denuded of their riparian forest buffers in some locations, where crop fields now border the stream. Without intact riparian forest, these sections of Marrowbone Creek are subject to increased rates of streambank erosion, potentially contributing to severely incised and slump-prone stream banks (Figure 2). In addition, a low-head dam exists between Alternatives C and D (Figure 3), which acts as a sediment trap and represents a barrier to fish movement.

Based on these findings, Alternatives C and E seem to offer the best opportunities for conserving fish habitat within Marrowbone Creek. Bridge construction at Alternative C is unlikely to have major impacts on native fish communities because the riparian canopy downstream is already degraded, benthic habitats are fairly homogenous and dominated by fine sediment, and additional sediment from construction at Alternative C is likely to be trapped by the dam located just

downstream. Bridge construction at Alternative E would likely lead to similarly limited impacts to instream communities. Alternatives A and B should be avoided if impacts to native fishes are a concern, as the stream reaches affected by a project at either of these locations currently have healthy riparian forests. In addition, Alternative A appeared to have the most diverse benthic habitat for fishes, which would make it the least-preferred site for a new bridge if fish habitat conservation is a decision criterion.

ACKNOWLEDGMENTS

We thank Hunter Greenway for assisting with the habitat surveys.

LITERATURE CITED

- Jenkins, R. E. and Burkhead, N. M. 1994. Freshwater Fishes of Virginia. American Fisheries Society, Bethesda, Maryland.
- Martin, Z. P. and Angermeier, P. L. 2015. Survey of stream habitat at the Murray Run restoration site in Roanoke County, Virginia. Project Report for Ecosystem Services, LLC. Project # 14-0037. 9 pages.
- Martin, Z. P. and Angermeier, P. L. 2018. Monitoring of Endangered Roanoke Logperch in Smith River Upstream of Philpott Reservoir. Project Report for the U. S. Army Corps of Engineers. 27 pages.
- Rosenberger, A., and Angermeier, P. L. 2003. Ontogenetic shifts in habitat use by the endangered Roanoke Logperch (*Percina rex*). *Freshwater Biology* 48(9): 1563-1577.
- Simonson, T. D., and Neves, R. J. 1992. Habitat suitability and reproductive traits of the Orange-fin Madtom *Noturus gilberti* (Pisces: Ictaluridae). *The American Midland Naturalist* 127(1): 115-124.

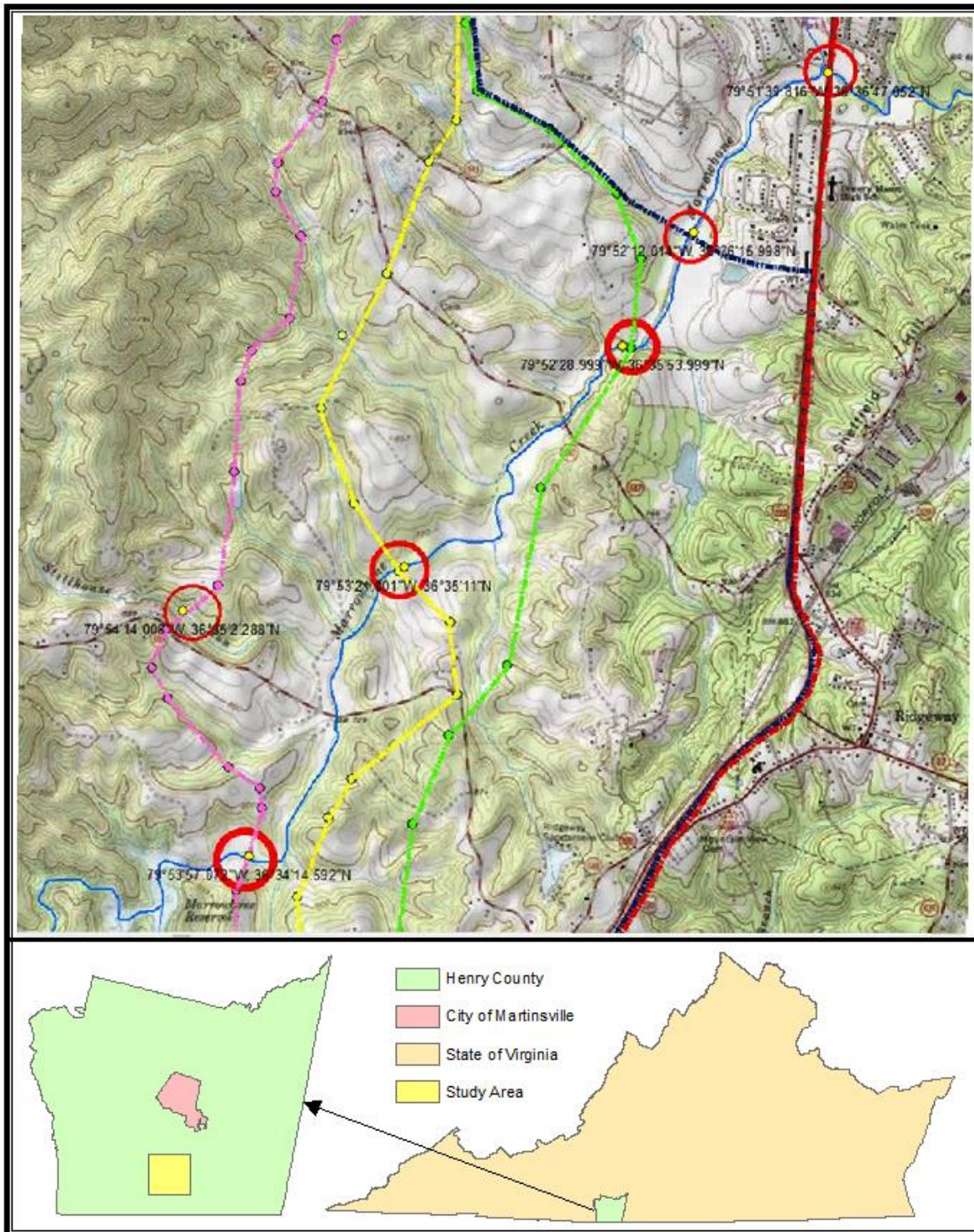


Figure 1. Marrowbone Creek Study Area: Yellow points with red circles around them on the main topographic map above represent the five alternative bridge crossing locations that were visited during the habitat study. The sixth such site (westernmost yellow point) on Stillhouse Creek, was not visited, as it is likely too small to support populations of *N. gilberti* or *P. rex*.

Table 1. Categories, particle descriptions, and size classes (Modified Wentworth scale) used to classify instream substrate conditions within Marrowbone Creek.

Substrate category	Substrate particle	Size
1	Silt	$\leq 0.06\text{mm}$
2	Sand	0.07-2.00mm
3	Gravel	3-16mm
4	Pebble	17-64mm
5	Cobble	65-256mm
6	Boulder	$>256\text{mm}$
7	Bedrock	-

Table 2. Stream characteristics recorded during fish habitat surveys conducted from May 15th to 17th, 2019 on Marrowbone Creek, in accordance with methods used by Martin and Angermeier (2015). Data for Alternative A are not shown because the sampling protocol was not completed; however, the site was visited and had slightly more diverse benthic habitat than was observed at the other four sites.

	Transect (m)	Width (m)	Average Depth (cm)	Dominant Substrate	Sub- dominant Substrate	Percent Silt Cover	Percent Embeddedness
<i>Alternative B</i>							
Upstream	200	6	28.4	Sand	Silt	86	90
	175	5.8	24.2	Silt	Gravel	90	72
	150	6	45.8	Sand	Silt	76	86
	125	6.5	26.2	Silt	Sand	60	62
	100	6.2	24.2	Sand	Sand	98	94
	75	6.2	22.4	Sand	Silt	86	88
	50	5.2	32.6	Silt	Silt	86	86
	25	7.6	40.8	Sand	Silt	74	70
At Bridge	0	7.6	24	Sand	Silt	96	94
Downstream	50	6.6	30	Sand	Sand	76	90
	100	6.1	25.4	Sand	Silt	92	96
	150	6.1	23.6	Sand	Silt	86	88
	200	5.2	30.4	Sand	Silt	96	78
	250	10.5	25.8	Sand	Silt	98	84
	300	6.8	29	Silt	Silt	94	80
	350	5	34.8	Sand	Silt	98	94
	400	7.6	27.4	Sand	Gravel	78	82
	450	5.7	20.2	Sand	Silt	86	66
	500	5.4	33.2	Sand	Silt	100	100
	550	6.3	25.2	Silt	Silt	94	96
	600	6.4	29.8	Silt	Silt	100	100
	Average	6.4	28.7	Sand	Silt	88.1	85.5
<i>Alternative C</i>							
Upstream	200	8.3	32.8	Sand	Silt	100	100
	175	8.3	20.8	Sand	Gravel	70	72
	150	8.4	23.8	Silt	Gravel	86	76
	125	8.8	32.6	Silt	Silt	96	94
	100	8.8	24.8	Silt	Sand	96	94
	75	7.9	34.2	Silt	Silt	92	80
	50	8.8	33.6	Sand	Silt	98	98
	25	8.0	23.6	Sand	Silt	64	62
At Bridge	0	8.1	19.0	Silt	Sand	68	86

	Transect (m)	Width (m)	Average Depth (cm)	Dominant Substrate	Sub- dominant Substrate	Percent Silt Cover	Percent Embeddedness
<i>Alternative C cont.</i>							
Downstream	50	7.4	24.4	Silt	Silt	74	92
	100	9.2	21.4	Silt	Silt	96	96
	150	10.5	14.8	Sand	Silt	70	72
	200	6.2	26.2	Silt	Silt	90	92
	250	7.3	33.0	Sand	Silt	92	92
	300	6.1	25.6	Sand	Silt	94	96
	350	6.7	35.4	Sand	Silt	96	98
	400	6.8	30.6	Sand	Silt	100	100
	450	7.1	32.8	Silt	Silt	100	100
	500	7.5	30.0	Sand	Silt	98	100
	550	8.3	24.6	Sand	Silt	100	98
	600	9.5	25.4	Sand	Silt	100	100
	Average	8.0	27.1	Sand	Silt	89.5	90.4
<i>Alternative D</i>							
Upstream	200	5.9	36.4	Sand	Silt	86	80
	175	10.3	54.0	Sand	Silt	90	86
	150	7.2	31.2	Sand	Silt	90	66
	125	8.2	22.8	Silt	Pebble	68	58
	100	7.8	27.8	Sand	Silt	92	84
	75	7.8	33.4	Sand	Silt	82	84
	50	8.2	29.8	Silt	Sand	90	88
	25	6.3	49.4	Sand	Silt	98	100
At Bridge	0	8.2	31.8	Sand	Silt	100	100
Downstream	50	7.7	30.4	Sand	Silt	78	92
	100	8.8	27.8	Sand	Silt	90	100
	150	9.6	28.8	Silt	Silt	98	100
	200	8.1	28.6	Boulder	Sand	68	32
	250	8.6	24.4	Silt	Silt	58	76
	300	9.5	23.2	Sand	Silt	88	88
	350	8.6	28.6	Sand	Silt	90	86
	400	8.3	32.6	Silt	Gravel	86	86
	450	8.3	24.6	Silt	Gravel	62	68
	500	8.2	28.2	Sand	Silt	94	100
	550	10.0	20.4	Silt	Bedrock	84	76
	600	9.2	25.6	Sand	Silt	84	88
	Average	8.3	30.5	Sand	Silt	84.6	82.8

	Transect (m)	Width (m)	Average Depth (cm)	Dominant Substrate	Sub- dominant Substrate	Percent Silt Cover	Percent Embeddedness
<i>Alternative E</i>							
Upstream	200	7.3	28.4	Silt	Sand	74	94
	175	7.3	26.1	Sand	Sand	69	66
	150	6.3	26.9	Sand	Silt	51	70
	125	6.7	31.9	Silt	Gravel	70	63
	100	6.7	32.7	Sand	Gravel	87	76
	75	5.8	37.6	Sand	Silt	83	87
	50	6.9	36.0	Sand	Gravel	94	93
	25	8.7	29.9	Sand	Silt	81	89
At Bridge	0	8.2	26.9	Sand	Silt	70	71
Downstream	50	8.9	28.9	Sand	Silt	79	80
	100	8.6	22.7	Sand	Silt	63	66
	150	10.1	19.3	Silt	Gravel	76	79
	200	7.4	32.0	Silt	Silt	83	80
	250	9.2	24.0	Sand	Silt	74	80
	300	8.4	25.7	Sand	Silt	87	89
	350	8.8	28.1	Sand	Silt	97	100
	400	9.1	27.1	Silt	Silt	94	89
	450	8.6	26.0	Sand	Silt	89	89
	500	8.8	18.9	Gravel	Sand	41	57
	550	8.7	26.0	Sand	Silt	94	96
	600	7.9	22.4	Sand	Silt	99	99
Average	8.0	27.5	Sand	Silt	78.8	81.5	



Figure 2. Unstable, eroding riverbank downstream of one of the proposed bridge construction locations (Alternative D) on Marrowbone Creek.



Figure 3. Low-head dam approximately 500 meters upstream of the Alternative D proposed bridge construction location (downstream of Alternative C) in Marrowbone Creek (viewed from downstream of the dam).

Final Report

Habitat Assessment Survey for Mussels at Route 220 Alternative Route Crossings of
Marrowbone Creek, Henry County, Virginia.

An Assessment Component of the Martinsville Southern Route 220 Connector Study

VDOT Project #: 0220, 044, 052, P101

Prepared by

Richard J. Neves and William F. Henley

Department of Fish and Wildlife Conservation

Virginia Tech

Blacksburg, Virginia 24061-0321

for

Virginia Department of Transportation

1401 East Broad Street

Richmond, Virginia 23219-2000

May 2019

Introduction

The Virginia Department of Transportation (VDOT) requested habitat assessments at five possible bridge crossings of Marrowbone Creek in Henry County, Virginia as a component of the Martinsville Southern Route 220 Connector Study, to determine whether mussels reside at these locations in the stream. The survey sites at the proposed crossings were labelled Alternatives A, B, C, D, and E (VDOT Survey Collection Records – Marrowbone Creek – ALTs A through E, Table 1, Figs. 1 through 6). The Virginia Department of Game and Inland Fisheries identified the James spinymussel (*Parvaspina collina*), green floater (*Lasmigona subviridis*), and Atlantic pigtoe (*Fusconaia masoni*) as possible rare species of occurrence in the creek, because of their suspected residence in nearby watersheds. The purpose of the surveys was to assess habitats at the sites for mussel suitability and whether mussels reside in the stream.

Materials and Methods

The habitats in the five survey sites in Marrowbone Creek were assessed in 100 m reaches, from 80 m downstream of the proposed crossings to 20 m upstream. The surveys were conducted on May 20 and 21, 2019 by Dick Neves and Bill Henley from the Freshwater Mollusk Conservation Center, Department of Fish and Wildlife Conservation, Virginia Tech, Blacksburg, Virginia. The abiotic assessments included observations on characteristics of riparian zones, banks, average water depth and turbidity, substrate, and occurrence of woody debris. Biotic assessments included observations made during timed searches using viewscopes of faunal occurrences, to include mussels. No snails were observed in the stream.

Results

Flow in Marrowbone Creek was relatively low, with water depths that ranged from 0.1 m to 1.25 m. The water was somewhat turbid, with visibility about 0.7 m. The weather was sunny and warm on both days, and water temperature was about 27° C. A total search effort of 3.33 work-

person-hours was expended at the five assessment sites; results of the five assessments are provided separately by alternative route.

Alternative Route A

The site was ≈ 900 m north from the driveway entrance at Route 689 of the residence of Mr. Ron Holt (Table 1, Fig. 1). Mr. Holt escorted us to a parking site at the edge of his pasture. From the parking place, we walked to the site through ≈ 280 m of pasture, then 220 m through thick forest to the site. The riparian zone was shaded due to complete coverage by lush undergrowth and trees. The channel was deeply incised, and bank heights were 3 m (VDOT Survey Collection Record – Marrowbone Creek – ALT A, Fig. 2). The bottom substratum was unsuitable for mussels, and consisted of loose, fine sand and silt with areas of fine gravel that were scattered within the reach. Submerged woody debris was common, and water depth was ≈ 0.3 m. No mussels were observed during a total of 1.0 h of search time (VDOT Survey Collection Record – Marrowbone Creek – ALT A, Table 1). Two muskrat middens were observed with small numbers of Asian clams (*Corbicula fluminea*). Live *C. fluminea* were common, but only in patches of consolidated fine gravel (Table 7). Crayfish and cyprinid minnows were uncommon.

Alternative Route B

We parked at the east side of Route 1060 at a gate that was ≈ 1000 m south of Magna Vista High School, alongside Marrowbone Creek (Table 1, Fig. 1). From the parking site, we hiked ≈ 540 m northeast along an overgrown farm road, then through young forest growth. The riparian zone was shaded by lush undergrowth and trees. The channel was deeply incised. The left and right descending bank heights were 2 and 1.5 m, respectively (VDOT Survey Collection Record – Marrowbone Creek – ALT B, Fig. 3). The bottom substrate was unsuitable for mussels, and consisted of very loose fine sand and silt with areas of fine gravel scattered within the reach.

Submerged woody debris was common, and water depth was ≈ 0.3 m. No mussels were observed during a total of 1.0 h of search time (VDOT Survey Collection Record – Marrowbone Creek – ALT B, Table 1). Live *C. fluminea* were uncommon, only in patches of consolidated fine gravel. Crayfish and fish fry were rare.

Alternative Route C

The site was ≈ 560 m northeast of the Route 687 bridge crossing over Marrowbone Creek (Table 1, Fig. 1). From the parking site aside the bridge, we entered the creek under the bridge, and waded downstream through a sinuous channel to the site with complete forest canopy.

The riparian zone was shaded due to complete coverage by lush undergrowth and trees. The channel was deeply incised, with banks that were about 2 m high (VDOT Survey Collection Record – Marrowbone Creek – ALT C, Fig. 4). Submerged wood debris and fallen timber were very common in the channel. The bottom substratum was unsuitable for mussels, consisting of loose, fine sand and silt, with no gravel. Water depth was ≈ 0.2 m. No mussels were observed during the 0.33 h of search time (VDOT Survey Collection Record – Marrowbone Creek – ALT C, Table 1). Live *C. fluminea* were uncommon, but no crayfish or fish were observed.

Alternative Route D

The site was ≈ 270 m south-southeast of our parking site at the creek-side dead-end of Farmingdale Drive. From the parking site, we hiked across a small creek and then through overgrown fields to the site (Table 1, Fig. 1). The riparian zone was shaded due to complete coverage by lush undergrowth and trees. The channel was deeply incised, with the left and right descending bank heights of 2.5 and 3.0 m, respectively (VDOT Survey Collection Record – Marrowbone Creek – ALT D, Fig. 5), and with no wood debris. The bottom substratum was unsuitable for mussels, consisting of loose sand, silt, and small areas of fine gravel, with water

depth of ≈ 0.3 m. No mussels were observed during 0.5 h of search time (VDOT Survey Collection Record – Marrowbone Creek – ALT D, Table 1). Live *C. fluminea* were common in the fine gravel. No crayfish or fish were observed.

Alternative Route E

The site was ≈ 115 m north of our parking site at a Salvation Army drop-off shed on the west side of Highway 220. From the parking site, we walked through a small mowed field to the site (Table 1, Fig. 1). The riparian zone was shaded by lush undergrowth and trees. The channel was deeply incised, with the left and right descending bank heights of 2.5 and 1.5 m, respectively (VDOT Survey Collection Record – Marrowbone Creek – ALT E, Fig. 6). The left descending bank was lush and forested, and the right bank was mown. The bottom substratum was unsuitable for mussels, and consisted of loose sand, silt, and patches of fine gravel. Water depth was ≈ 0.3 m. No mussels were observed during the 0.5 h of search time (VDOT Survey Collection Record – Marrowbone Creek – ALT E, Table 1). Live *C. fluminea* were present in the fine gravel patches. No crayfish or fish were observed.

Conclusions

Physical habitat in Marrowbone Creek was similar at all 5 sites, with a deeply incised channel and an unconsolidated substratum of shifting sand and fine sediments that was unsuitable for mussels. The Asian clam was the only mollusk observed, and it varied in abundance from rare to common. Based on the absence of mussels in the stream, any of the 5 alternative routes would be suitable as a crossing, with no impact on mussels.

VDOT Survey Collection Record – Marrowbone Creek – ALT A

VDOT Project Name: Martinsville Southern Connector Study, Route 220

VDOT Project Number: 0220-044-052-P101

Project Description: Mussel Habitat Assessment – Alt A site

Survey Type: Habitat Assessment; 80 m downstream to 20 m upstream

Stream Waterbody: Marrowbone Creek

County: Henry

Drainage: Smith River

USGS Quadrangle Map: Northwest Eden

Bridge Coordinates Lat: 36.570720 Long: -79.899409

GPS Projection: WGS84 GPS Accuracy: 5 m

Survey Date(s): 05/20/19

Weather: Clear/Sunny Water Clarity: turbid – 0.66 m visibility Water Temperature: ~27 C

Personnel: Virginia Tech: Dick Neves and Bill Henley

Species Observed (Counts): None

Total Number of Mussels Observed: None

Survey Effort: 1.0 person-hours

Total Catch-Per-Unit-Effort: 0.0 mussels/h

Other Mollusks: Corbicula fluminea common; no snails

Comments: Viewscopes only. Two muskrat middens – all Corbicula; riparian – thick, shaded canopy; deeply incised channel with 3 m banks; substrate very unstable – loose fine sand/silt with small areas of fine gravel where Corbicula were observed. Crayfish rare. Water depth mean about 0.3 m. Submerged woody debris common.

VDOT Survey Collection Record – Marrowbone Creek – ALT B

VDOT Project Name: Martinsville Southern Connector Study, Route 220

VDOT Project Number: 0220-044-052-P101

Project Description: Mussel Habitat Assessment – Alt B site

Survey Type: Habitat Assessment; 80 m downstream to 20 m upstream

Stream Waterbody: Marrowbone Creek

County: Henry

Drainage: Smith River

USGS Quadrangle Map: Northwest Eden

Bridge Coordinates Lat: 36.586389 Long: -79.889167

GPS Projection: WGS84 GPS Accuracy: 5 m

Survey Date(s): 05/20/19

Weather: Clear/Sunny Water Clarity: Turbid – 0.66 m visibility Water Temperature:~ 27 C

Personnel: Virginia Tech: Dick Neves and Bill Henley

Species Observed (Counts): None

Total Number of Mussels Observed: None

Survey Effort: 1.0 person-hours

Total Catch-Per-Unit-Effort: 0.0 mussels/h

Other Mollusks: Corbicula fluminea uncommon; no snails observed

Comments: Viewscopes only. No muskrat middens. Corbicula – uncommon. Riparian – thick, shaded canopy; deeply incised channel – left descending bank 2 m, right descending bank 1.5 m; substrate very unstable – fine sand/silt with small areas of fine gravel where Corbicula were observed. Crayfish rare. Water depth mean about 0.3 m. Submerged woody debris common. Fish fry only were observed.

VDOT Survey Collection Record – Marrowbone Creek – ALT C

VDOT Project Name: Martinsville Southern Connector Study, Route 220

VDOT Project Number: 0220-044-052-P101

Project Description: Mussel Habitat Assessment – Alt C site

Survey Type: Habitat Assessment; 80 m downstream to 20 m upstream

Stream Waterbody: Marrowbone Creek

County: Henry

Drainage: Smith River

USGS Quadrangle Map: Northwest Eden

Bridge Coordinates Lat: 36.598333 Long: -79.874722

GPS Projection: WGS84 GPS Accuracy: 5 m

Survey Date(s): 05/20/19

Weather: Clear/Sunny Water Clarity: Turbid – 0.66 m visibility Water Temperature: ~27 C

Personnel: Virginia Tech: Dick Neves and Bill Henley

Species Observed (Counts): None

Total Number of Mussels Observed: None

Survey Effort: 0.33 person-hours

Total Catch-Per-Unit-Effort: 0.0 mussels/h

Other Mollusks: Corbicula fluminea uncommon; no snails observed

Comments: Viewscopes only. No muskrat middens. Corbicula – uncommon. Riparian – thick, shaded canopy; deeply incised channel – left descending bank 2 m, right descending bank 2 m; substrate very unstable – fine sand/silt with small areas of fine gravel where Corbicula were observed, and sparse rock outcrops. Water depth mean about 0.2 m. Submerged woody debris and fallen logs common. Crayfish not observed.

VDOT Survey Collection Record – Marrowbone Creek – ALT D

VDOT Project Name: Martinsville Southern Connector Study, Route 220

VDOT Project Number: 0220-044-052-P101

Project Description: Mussel Habitat Assessment – Alt D site

Survey Type: Habitat Assessment; 80 m downstream to 20 m upstream

Stream Waterbody: Marrowbone Creek

County: Henry

Drainage: Smith River

USGS Quadrangle Map: Northwest Eden

Bridge Coordinates Lat: 36.604444 Long: -79.870004

GPS Projection: WGS84 GPS Accuracy: 5 m

Survey Date(s): 05/21/19

Weather: Clear/Sunny Water Clarity: Turbid – 0.3 m visibility Water Temperature:~ 27 C

Personnel: Virginia Tech: Dick Neves and Bill Henley

Species Observed (Counts): None

Total Number of Mussels Observed: None

Survey Effort: 0.50 person-hours

Total Catch-Per-Unit-Effort: 0.0 mussels/h

Other Mollusks: Corbicula fluminea common; no snails observed

Comments: Viewscopes only. No muskrat middens. Corbicula – uncommon. Riparian – thick, shaded canopy; deeply incised channel – left descending bank 2.5 m, right descending bank 3 m; substrate very unstable – fine sand/silt with very few areas of fine gravel. Water depth mean about 0.3 m. No crayfish or adult fish observed.

VDOT Survey Collection Record – Marrowbone Creek – ALT E

VDOT Project Name: Martinsville Southern Connector Study, Route 220

VDOT Project Number: 0220-044-052-P101

Project Description: Mussel Habitat Assessment – Alt E site

Survey Type: Habitat Assessment; 80 m downstream to 20 m upstream

Stream Waterbody: Marrowbone Creek

County: Henry

Drainage: Smith River

USGS Quadrangle Map: Northwest Eden

Bridge Coordinates Lat: 36.613070 Long: -79.8861060

GPS Projection: WGS84 GPS Accuracy: 5 m

Survey Date(s): 05/21/19

Weather: Clear/Sunny Water Clarity: Turbid – 0.66 m visibility Water Temperature: ~27 C

Personnel: Virginia Tech: Dick Neves and Bill Henley

Species Observed (Counts): None

Total Number of Mussels Observed: None

Survey Effort: 0.50 person-hours

Total Catch-Per-Unit-Effort: 0.0 mussels/h

Other Mollusks: No Corbicula fluminea observed

Comments: Viewscopes only. No muskrat middens. Riparian – thick, shaded canopy on left descending bank, mowed field on right descending bank; deeply incised channel – left descending bank 2.5 m, right descending bank 1.5 m; substrate very unstable – fine sand/silt with very few areas of fine gravel. Water depth mean about 0.3 m. Sparse submerged woody debris and no fallen logs observed. No crayfish or fish observed.

Table 1. Global position system (GPS) coordinates of the Alternative Route 220 Crossings A, B, C, D, and E of Marrowbone Creek, Henry County, Virginia. Unit of measure for search effort expended at the proposed crossings was work-person-hours (WPH).

Site	Latitude	Longitude	Search Effort (WPH)	Mussels Collected	CPUE (mussels/h)
Alternative A	36.570720	-79.899409	1.00	0	0.0
Alternative B	36.586389	-79.889167	1.00	0	0.0
Alternative C	36.598333	-79.874722	0.33	0	0.0
Alternative D	36.604444	-79.870004	0.50	0	0.0
Alternative E	36.613070	-79.861060	0.50	0	0.0

Figure 1. Aerial photograph of the Alternative Route 220 Crossings A, B, C, D, and E of Marrowbone Creek, Henry County, Virginia.

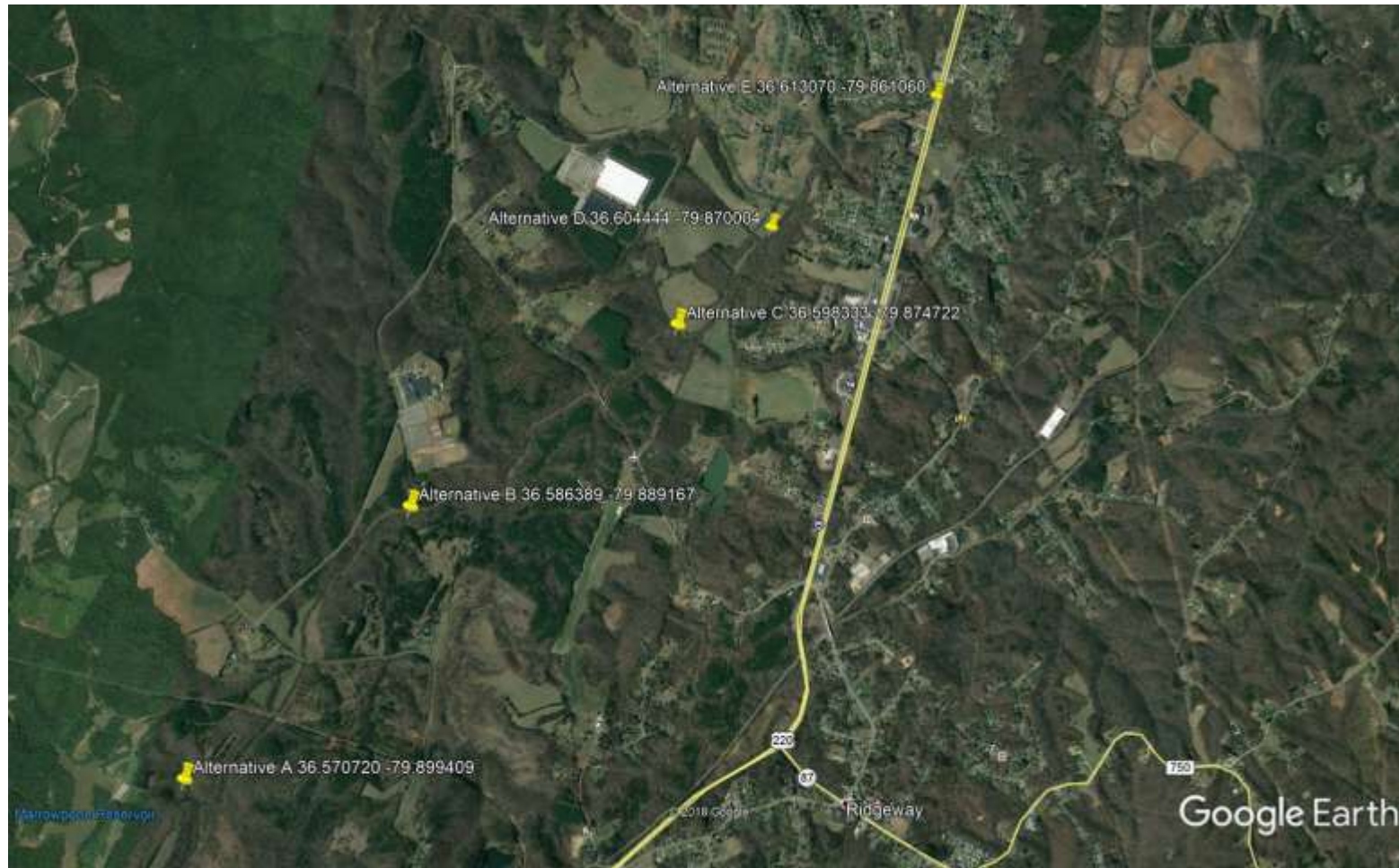


Figure 2. Mussel habitat assessment site at the Route 220 Bypass Alternative Route A crossing of Marrowbone Creek, Henry County, Virginia, surveyed on May 20, 2019.



Figure 3. Mussel habitat assessment site at the Route 220 Bypass Alternative Route B crossing of Marrowbone Creek, Henry County, Virginia, surveyed on May 20, 2019.



Figure 4. Mussel habitat assessment site at the Route 220 Bypass Alternative Route C crossing of Marrowbone Creek, Henry County, Virginia, surveyed on May 20, 2019.



Figure 5. Mussel habitat assessment site at the Route 220 Bypass Alternative Route D crossing of Marrowbone Creek, Henry County, Virginia, surveyed on May 21, 2019.



Figure 6. Mussel habitat assessment site at the Route 220 Bypass Alternative Route E crossing of Marrowbone Creek, Henry County, Virginia, surveyed on May 21, 2019.



Figure 7. Example of *Corbicula fluminea* collected at the Route 220 Bypass Alternative Route A crossing of Marrowbone Creek, Henry County, Virginia, surveyed on May 20, 2019.

